JETIR.ORG ISSN: 2349-5162 | ESTD Year : 2014 | Monthly Issue
JOURNAL OF EMERGING TECHNOLOGIES AND INNOVATIVE RESEARCH (JETIR)
An International Scholarly Open Access, Peer-reviewed, Refereed Journal

SIMULATION OF GRID CONNECTED SOLAR PV WITH MULTILEVEL INVERTER FOR INTERFACING PHOTO-VOLTAIC CELL

[1] Devendra Kumar Dhankar, [2] Uma Shankar Patel
[1] PG Student, [2] Assistant Professor Author
[1] Dept. of EEE, Raipur Institute of technology,
[1] Dept. of EEE, Raipur Institute of technology, Raipur, India

Abstract: This paper is based on the modelling of solar PV module with MPPT techniques and then connected to the multilevel inverter for interfacing after that connected to grid like loads. In this simulation the major part is maximum power point control which can be accomplished by various methods and fuzzy control system found to be very attractive now a days because it sets the rule table for particular input what should be the output and the input value need not to be very accurate. According to the variations of solar radiation due to the weather , time and location the value needs to be set and get the desired values after that a multilevel inverter has been connected to convert the output and connected to load grid as per the load end requirements. Simulation is done on a Matlab software and the result is analyzed.

Index Terms - Maximum power point tracking system (MPPT), Pulse Width Modulation (PWM), Insulated gate bipolar transistor (IGBT), Total harmonic distortion (THD), static synchronous compensator (STATCOM), and fuzzy logic control (FLC)

I. INTRODUCTION

With more demand for electricity, continuously raising fuel costs and more concerns of global climate change have leads to more and more use of renewable energy sources. These energy resources have got more fame due to the depletion of non-renewable energy sources and their adverse impact on the environment. The energy extracted from Solar is one of the alternative renewable energy sources. In case of solar PV, the energy is collected as dc which, further can be converted into ac by the use of inverter and then subsequently fed to utility grid or it may be used in isolated load. The inverter output can be fed to the grid as well as standalone system. The main objective of Grid connected SPV system is to supply the local loads and any surplus power generation have to be injected into the grid [1]

Energy not only plays an important role in our life but also in the overall economy of the country. The requirement for energy is increasing in our daily life due to the industrial revolution. In the most developing country like India, the large share of energy generation mainly depends upon non-renewable energy sources. The gradual depletion of these sources such as fossil fuels, oils, etc. leading the developing countries towards the un-sustainability of civilization. Along with that, the generation of energy through conventional sources is also a reason for greenhouse gases. It has become a global challenge to reduce the emission of greenhouse gasses like CO2 and CO3 to ensured secure, clean, and affordable energy. Whereas clean and sustainable energy is perfectly generated through renewable energy sources [1]. There are many renewable sources of energy such as solar energy, wind energy, Hydro energy, etc. The Photovoltaic (PV) system is the most efficient renewable source of energy which has taken the great attention of the researchers.
The MPPT working principle is based on the maximum power transfer theory. The power delivered from the source to the load is maximized when the input resistance seen by the source matches the source resistance. Therefore, in order to transfer maximum power from the panel to the load the internal resistance of the panel has to match the resistance seen by the PV panel. For a fixed load, the equivalent resistance seen by the panel can be adjusted by changing the power converter duty cycle [4].

With the modern lifestyles and the fast growth in industries the energy supply and demand chain has been subjected to remarkable strain. In addition, the issues of climate change and the need to diminish carbon footprints have added to the strong thrust for companies and nations to invest in alternate energy sources, particularly the renewable energy (RE) resources. Among the available RE resources, SPV source has emerged as one of the finest green energy resource and seen as a better replacement for conventional energy. The contribution of the energy harvested through the SPV systems had been significant in the past decade in meeting the national as well as international energy demands. In addition, the enhanced scale and eco-friendly nature of solar energy have attracted many researchers to propose scholarly research in this area. [2].

Many researchers have done a lot of work in improving array configuration, parameter evaluation and also in the field of improvement of MPPT.MPPT is one of the most cost effective way to improve the overall system efficiency. Depending upon the environmental conditions the location of MPPT changes. The purpose of role of various algorithm is to control the duty cycle. This is done in such a manner that the actual load line as seen by the PV array coincides with that of the load at which maximum power is extracted from the panel.

There are many different techniques for maximum power point tracking of photovoltaic (PV) arrays listed in the literature. The conventional MPPT method includes perturbation and observation (P&O), incremental conductance (IC), voltage-feedback methods etc. Fuzzy logic controls (FLC), neural network, genetic algorithm are intelligent method. These methods vary in complexity, sensors required, convergence speed, and cost, range of effectiveness, implementation Hardware and popularity. [3]

The methodology used in this paper basically depends upon the predetermined values of inputs and outputs. If the Solar Panels to be installed anywhere in the world the weather files are available in the government websites and the detailed analysis of the weather is also available. According to these analysis we can design the membership functions, rules and outputs. So in the form of PVB (positive very big), NB (Negative big), NS (Negative small) like this. So we can design an intelligent maximum power point tracking system by using fuzzy logic system with the predetermined set of rules and outputs. Now a days the efficiency of solar PV array are near about 15 to 20 %. We can increase this efficiency by using this maximum power point tracking system. We have taken an example from a site from the north India. We can do this analysis anywhere in the world and enhance the outputs.

II. Electrical Model of PV cell

Implements a PV array built of strings of PV modules connected in parallel. Each strings consists of strings connected in series. Parallel strings 40 and series connected modules per strings 10. With open circuit voltage 37.14V and short circuit current 8A.

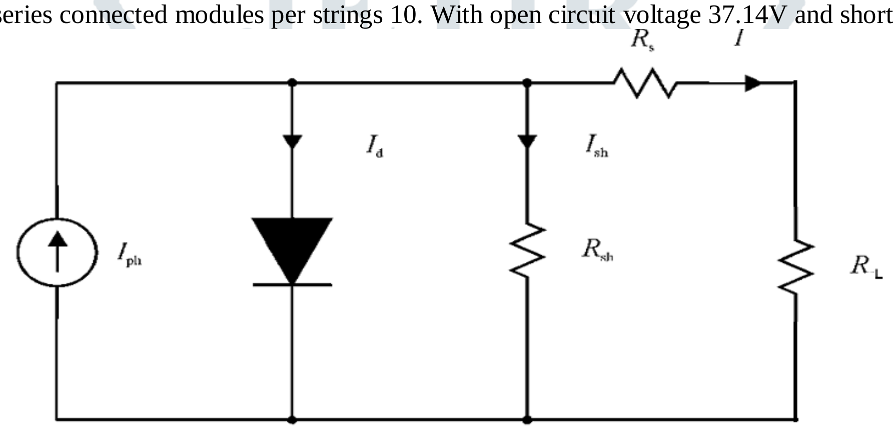

Fig -1: P-V cell Model

$$I = I_{D-} I_{RP-} I_{ph} \ldots\ldots (1)$$

$$I = I_{ph-} I_{0-} \left[exp\left(\frac{V+IRs}{V_T}\right) - 1\right] - \left[\left(\frac{V+IRs}{R_p}\right)\right] \ldots\ldots (2)$$

$$I = n_p I_{ph-} \ n_p I_{rs-} \left[exp\left(\frac{q}{KTA} * \frac{V}{n_s}\right) - 1\right] \ldots\ldots (3)$$

$$I_{rs} = I_{rr}\left[\frac{T}{T_R}\right]^3 exp\left(\frac{qE_G}{KA} \left[\frac{1}{T_r} - \frac{1}{T}\right]\right) \ldots\ldots (4)$$

$$E_{G=} \ E_G \ (0) \ \frac{\alpha T^2}{T+\beta} \ldots\ldots (5)$$

$$I_{ph} = [I_{scr} + K_i(T - T_r)]\frac{S}{1000} \ldots\ldots (6)$$

Where, Iph is the Insolation current, I is the Cell current, I0 is the Reverse saturation current, V is the Cell voltage, Rs is the Series resistance, Rp is the Parallel resistance, VT is the Thermal voltage (KT/q), K is the Boltzmann constant, T is the Temperature in Kelvin, and q is the Charge of an electron. [3]

In this paper a review of major MPPT techniques used in major PV standalone system are presented and gives a detailed review on various MPPT techniques used in this work. The I-V and P-V characteristics with different irradiation and temperature variation are shown in figure below.

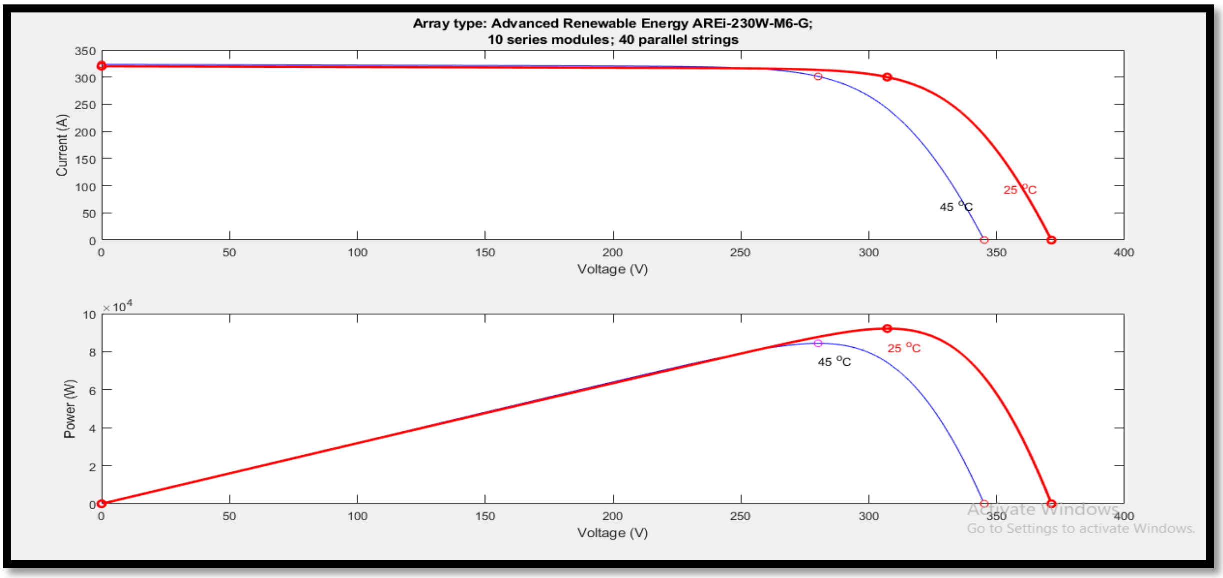

Fig -2: I-V and P-V Characteristics

III. Boost Converter

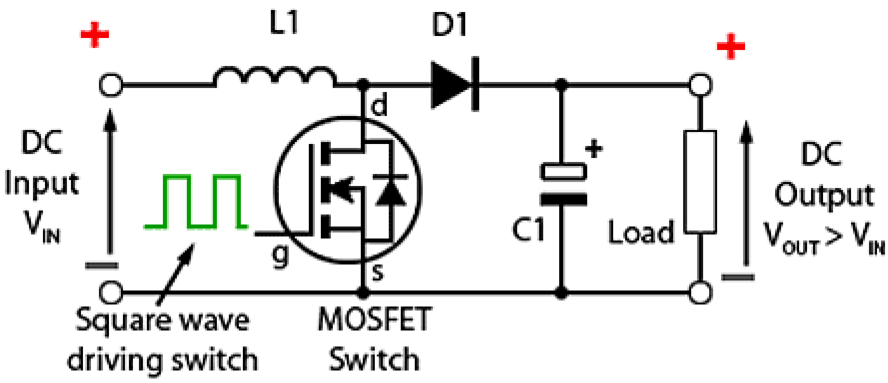

Fig -3: Equivalent circuit diagram of boost converter

The Fig.3 shows a step up or PWM boost converter. It consists of a dc input voltage source Vg; boost inductor L, controlled switch S, diode D, filter capacitor C, and the load resistance R. When the switch S is in the on state, the current in the boost inductor increases linearly and the diode D is off at that time. When the switch S is turned off, the energy stored in the inductor is released through the diode to the output RC circuit. In this way we get the desired output voltage by this boost converter. We can easily regulate its output voltage by varying the output resistance. [5]

$$V_{out} = \frac{1}{1-D} V_{in} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (7)$$

$$R_{pv} = (1-D)^2 R_{out} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (8)$$

IV. Maximum Power Point Tracking

The MPPT control is a fundamental in order to obtain a good performance on the overall system. The MPPT techniques can be categorized as direct and indirect methods. The direct method includes perturbation and observation method, fuzzy logic method, neural network method and incremental conductance method. In this work we review two different fuzzy logic control methods and trying to achieve optimum output by comparison in the overall installed system of such rating.

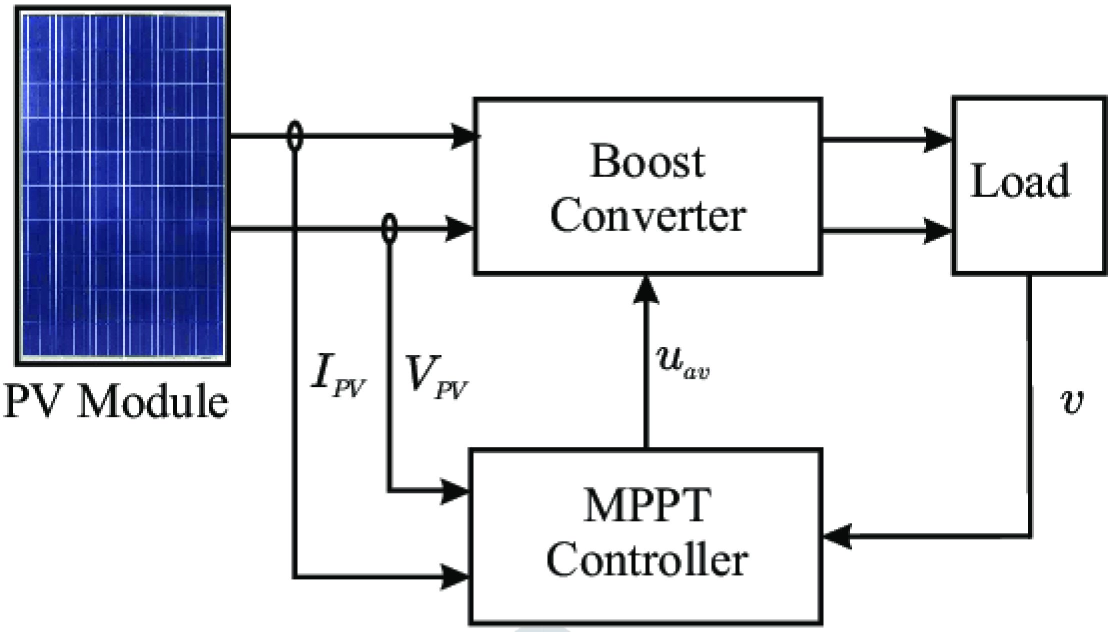

Fig -4: Maximum power point tracking system

V. Fuzzy Logic control

Renewable energy sources has a wide range of applications by using fuzzy control system. From the last few years the requirement of fuzzy has been increased due to it's easy to design and understand factors.FLC system also deals with the imprecise or inaccurate inputs which does not need any accurate mathematical model for controller.

Fuzzy logic controller process can be assorted into three categories:-
1. Fuzzification
2. Rule Evaluation
3. Defuzzification.

The First Category i.e. Fuzzification it takes the crisp input, for example, the change in input voltage levels. After taking the Crisp Input, it converts into fuzzy input with the stored membership function. When the fuzzy values are designed then, the first stage of FLC i.e. fuzzification takes place. [8]

Triangular membership function are used as they are easier to implement and quicker to process. In the proposed fuzzy system, seven fuzzy sets have been considered for each input: negative very big (NVB), negative big (NB), and negative medium (NM), negative small (NS) zero (ZE), positive small (PS), positive medium (PM) and positive big (PB), positive very big (PVB). Before fuzzification, the input variables are normalized using base values.

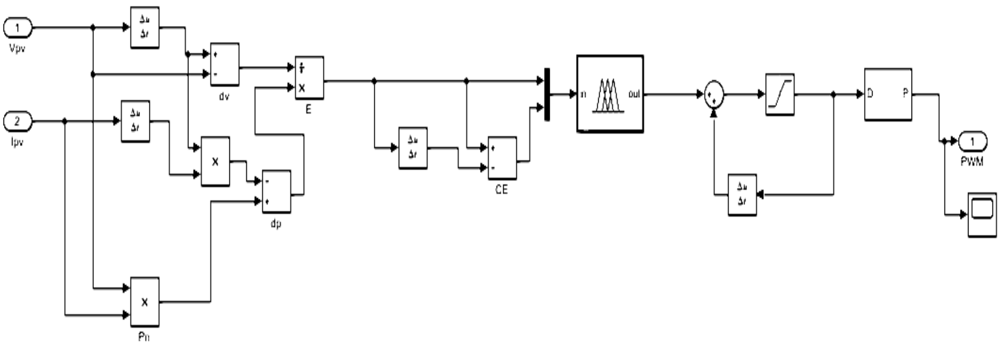

Fig -5: MPPT based on fuzzy logic system

VI. Proposed Model

Solar PV has been designed with 40 parallel strings and series connected modules per sting is 10 with input 1 sun irradiance in W/m2 and input 2 is temperature in degree Celsius. We have taken two different fuzzy logic control system from two reference papers and monitor the outputs in our designed system from the results and analysis we can design our own fuzzy control system for much optimized output. After the solar PV boost converter is connected to boost the output and to control the duty cycle and MPPT a fuzzy logic control system has been designed so as to achieve the maximum output at that instant of radiation. So we designed a rule base system to achieve maximum power point. After the boost converter various filters are connected to make the output linear and then connected it with grid or load.

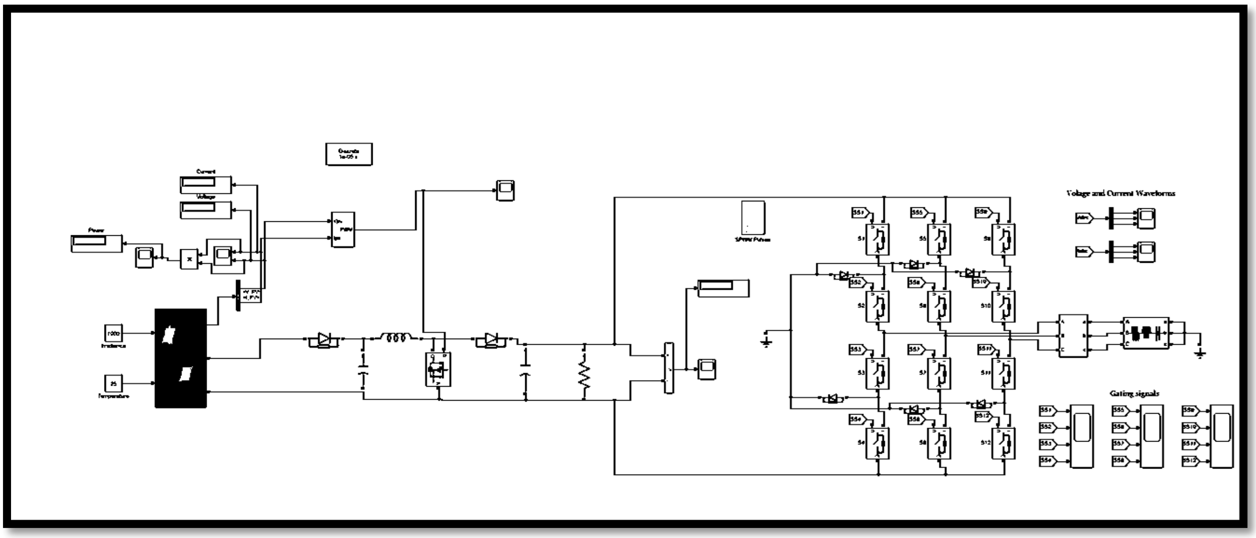

Fig -6: Proposed Model

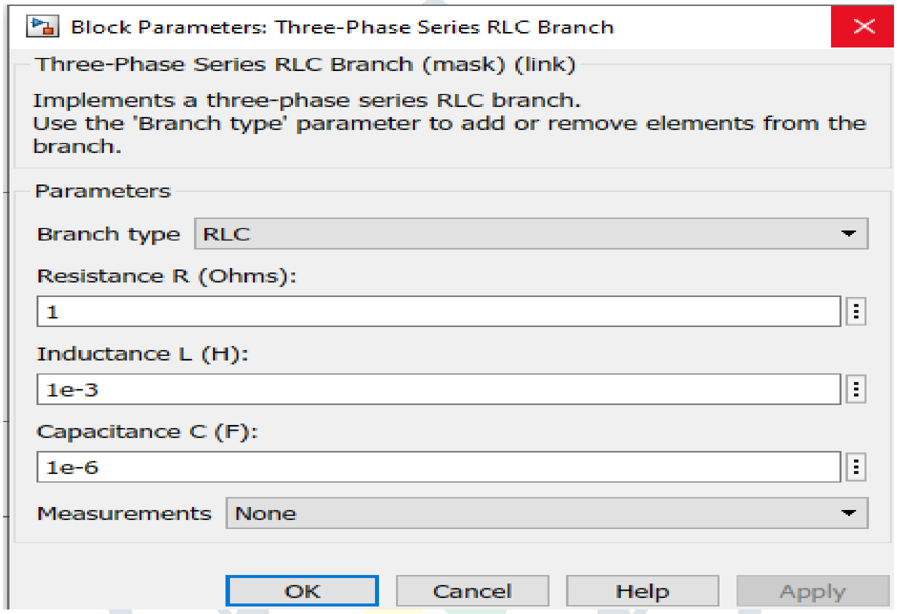

Fig -7: RLC branch parameters

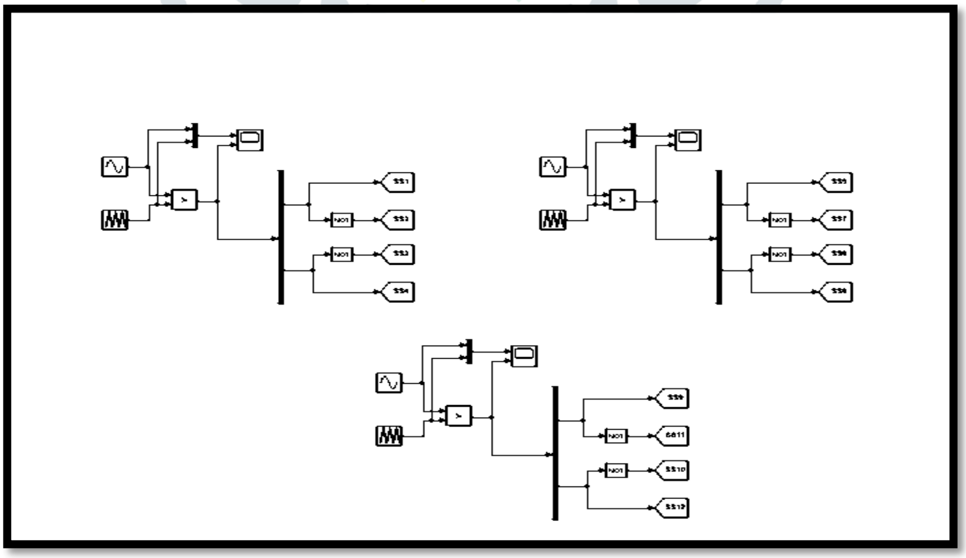

Fig -8: SVPWM Pulses

dE is P	dE is Z	dE is N	E
PS	PM	PB	N
N	Z	P	Z

NB	NM	NS	P

Table 1 Fuzzy Rules

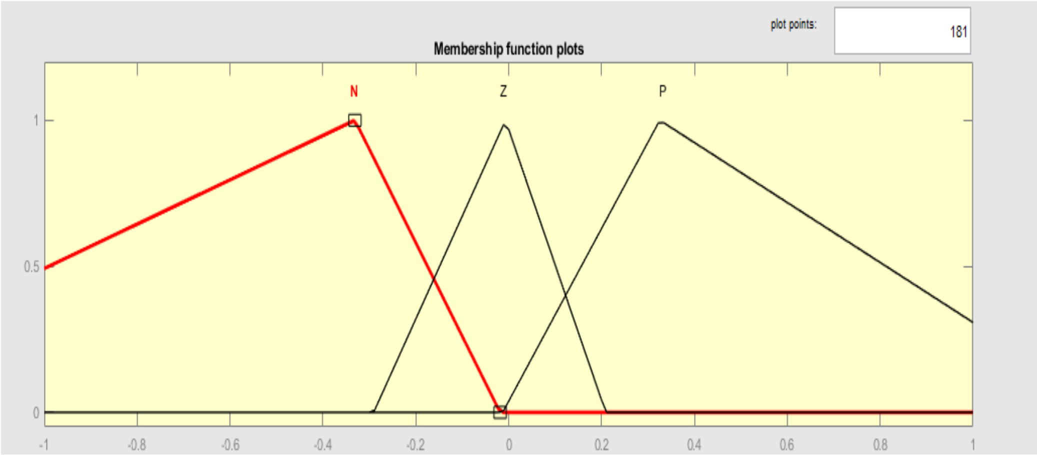

Fig -9: Membership function plots for E

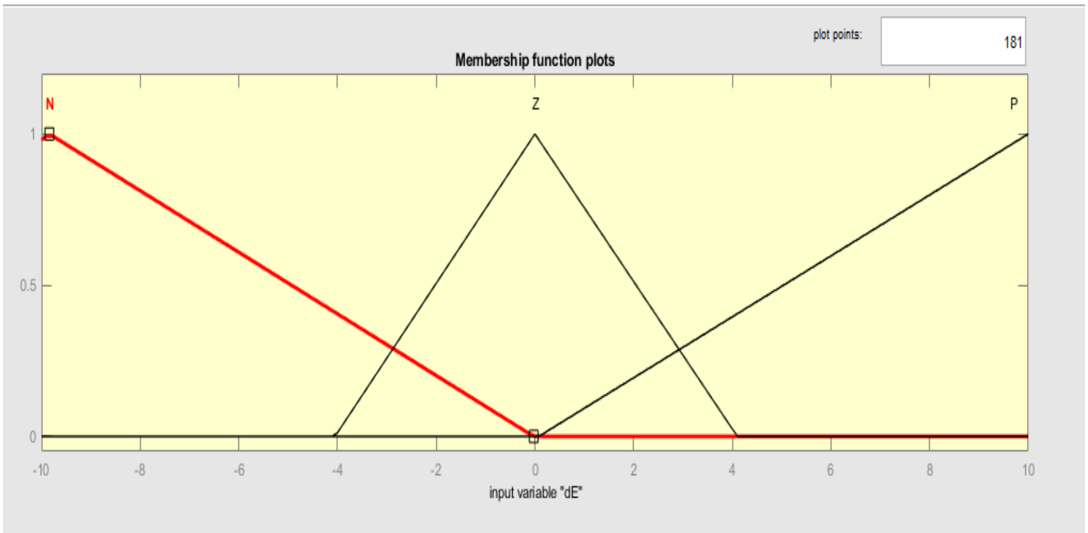

Fig -10: Membership function plots for dE

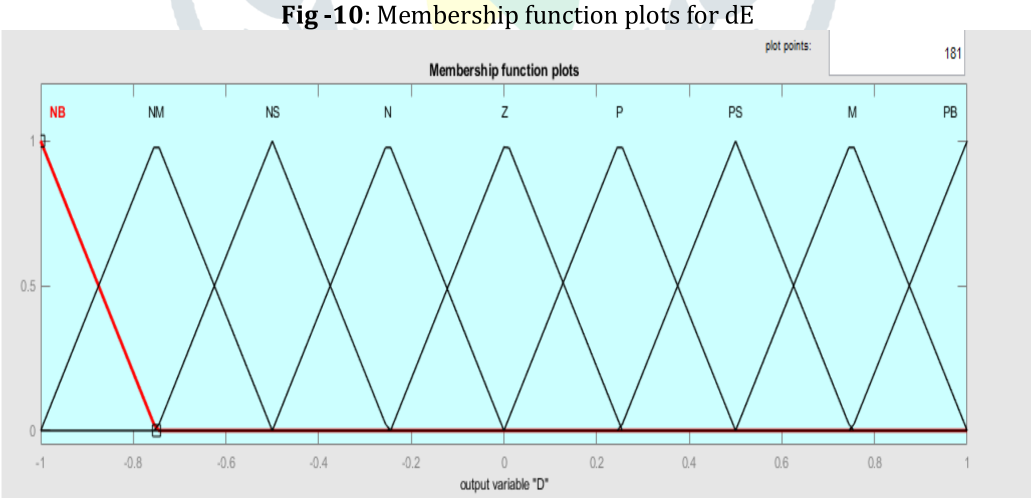

Fig -11: Membership function plots for D

VII. SIMULATION RESULTS

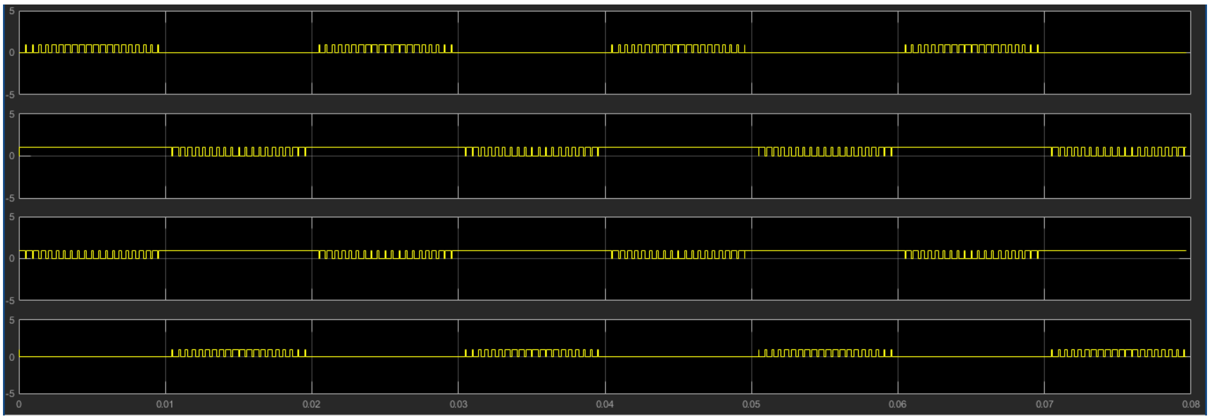

Fig -12: Gate signals

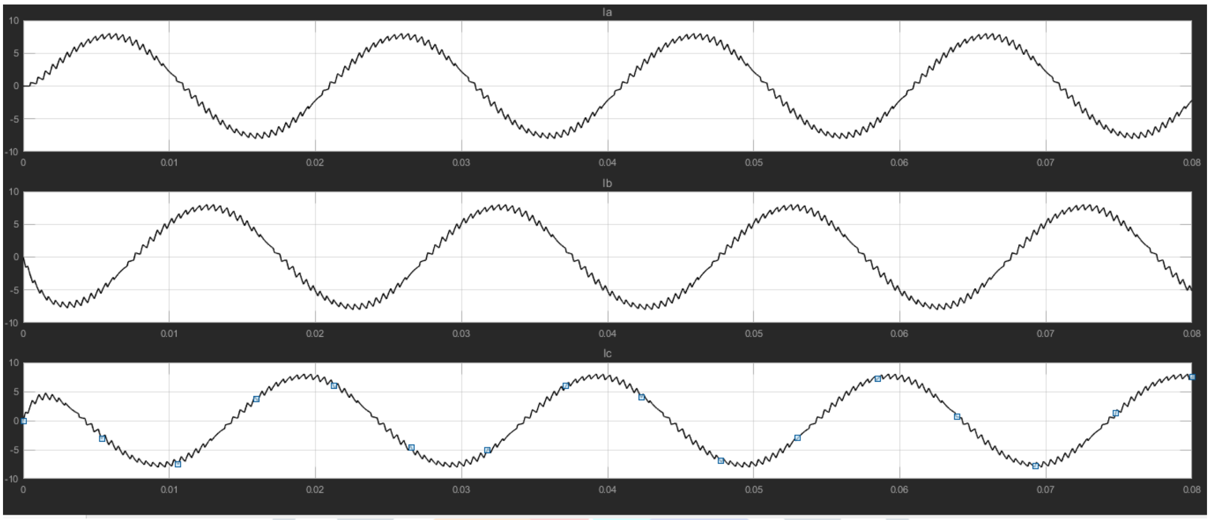

Fig -13: Current Waveforms

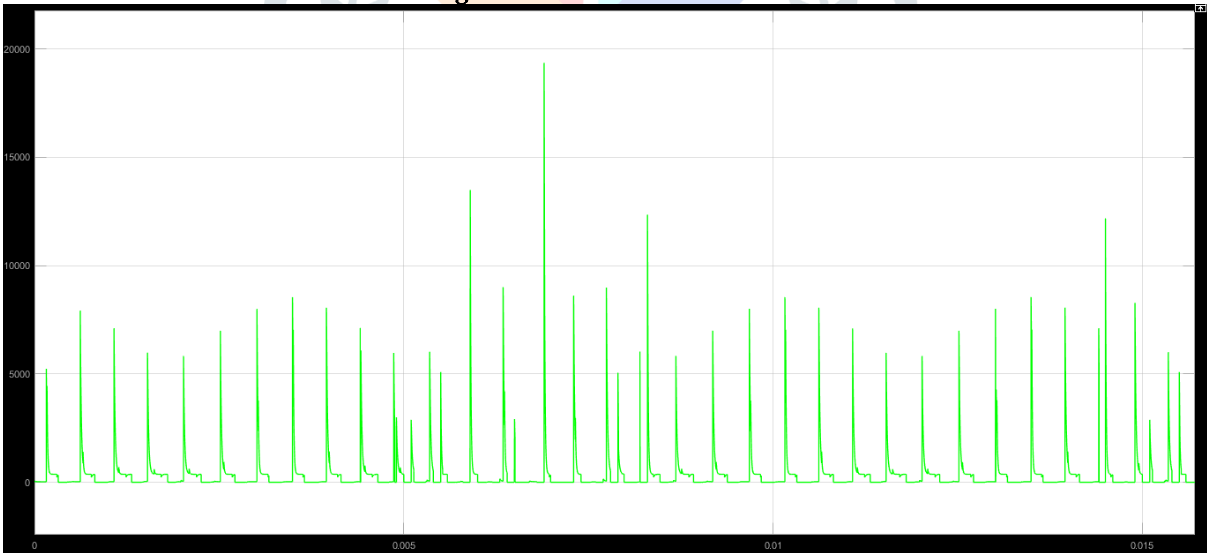

Fig -14: Voltage before entering MLI

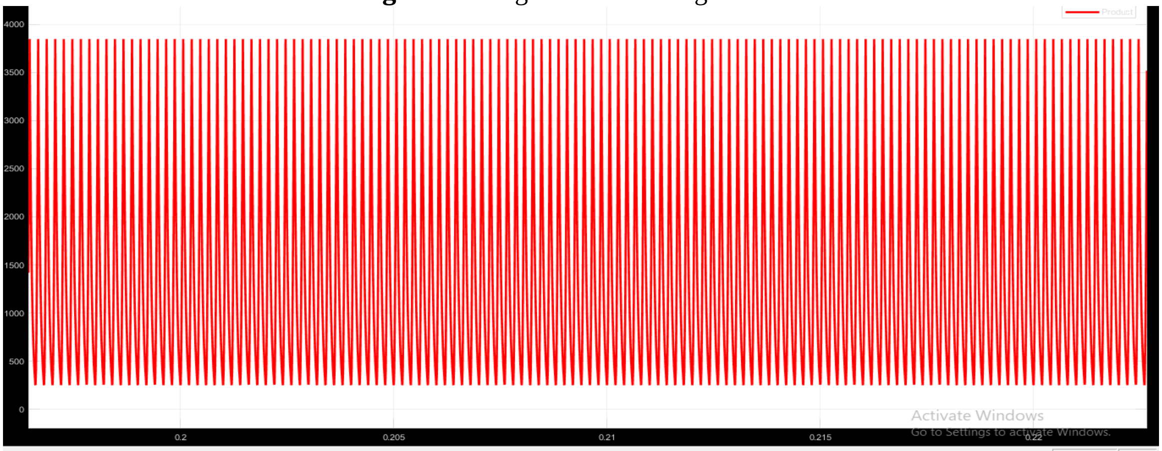

Fig -15: Power output

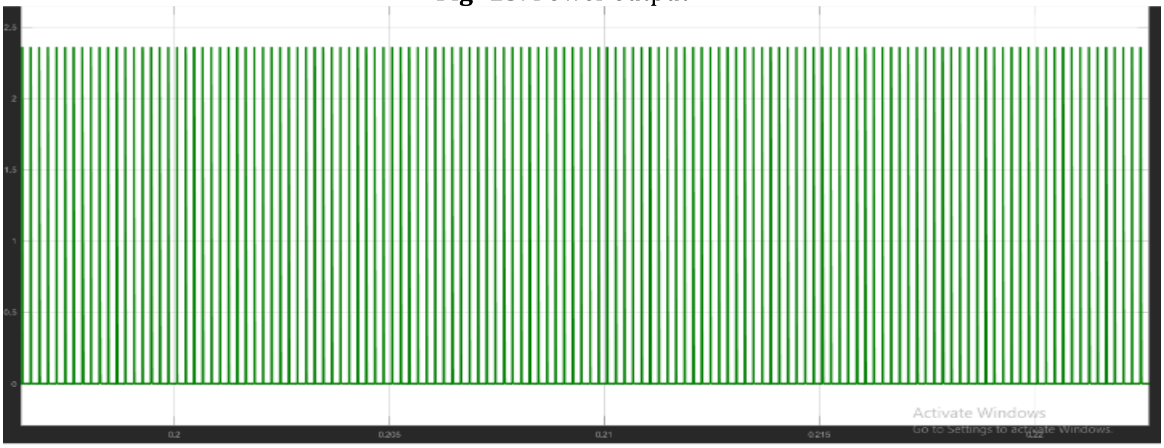

Fig -16: Voltage output after boost converter

The Simulation of the proposed model has been done in the Matlab software with both fuzzy logic control system and above mentioned the output results in the figures.

Table -3: Parameters used

Parameters	
Solar PV open circuit voltage	37.14 V
Short Circuit Current	8A
Resistance	50Ω
Inductance	350μH
Capacitance	560μF

CONCLUSIONS

The PV model was simulated and analyzed for testing the performance of MPPT techniques with conventional and fuzzy logic controller we have done study on various fuzzy logic controllers and the main aim is to control the duty cycle of the boost converter in order to obtain maximum power possible from the PV generator system. The selection and type of Fuzzy logic system and the fuzzy rules we have selected have a significant impact on the output of the controller performance. In this work the PV array along with the boost converter has been analyzed and designed and after that the output is connected to multilevel inverter to convert the DC output into AC output so that to transfer it to the load or grid. We can see from the output that the waveform of current is sinusoidal but with little bit distortion. Work has to be done in future to improve the power quality and enhance the output by using various filters. Further enhancement can be done with different temperature and irradiance and accuracy with outputs can be increased in future works.

REFERENCES

[1] Subramanian Krithiga, NanjappaGounderAmmasai, “Power electronic configuration for the operation of PV system in combined grid-connected and stand-alone modes,” IET Power Electronics, 2014, Vol. 7, Issue 3, pp. 640–647.

[2] Binhan Kanchan Bijaykant, Shashi Minz Intelligent Control Algorithm for Maximum Power Point Tracking of PV Arrays International Journal of Innovative Research in Science, Engineering and Technology (An ISO 3297: 2007 Certified Organization) Vol. 5, Issue 9, September

[3] J.A. Gow, C.D. Manning “Development of a Photovoltaic Array Model for Use in Power Electronics Simulation Studies”, IEE Proceedings on Electric Power Applications, Vol. 146, No. 2, pp. 193

[4] E. Aranda, J.Gala´ N, M. Cardona, and J.Rquez, "Measuring the I-V curve of PV generators," IEEE Ind. Electron. Mag., vol. 3, no. 3, pp. 4-14, September 2009.

[5] Journal of University of Shanghai for Science and Technology ISSN: 1007-6735 Design and Simulation of MPPT Control Strategy for Solar PV by Using Fuzzy Control Abhishek Verma1, Brahma Nand Thakur2,

[6] Zadeh. L.A, Fuzzy sets, Information and Control, Vol. 8, pp. 338-353. 1965.

[7] M. A. Usta, O. Akyaszi and I.H. Atlas, “Design and performance of solar tracking system with fuzzy logic Controller”, Sixth International Advanced Technologies Symposium (IATS’11), Elazig, Turkey, May16-18, 2011.

[8] C. Larbes, S.M. Aı¨t Cheikh*, T. Obeidi, A. Zerguerras, “ Genetic algorithms optimized fuzzy logic control for the maximum power point tracking in the photovoltaic system”, Renewable Energy, Vol. 34, Issue 19, pp. 2093-2100-55, 2009.

[9] Salas,V., OlÕ´s,E., Barrado,A.and La´zaro,A. 2006. Review of the maximum power point tracking algorithms for stand-alone photovoltaic systems. Solar Energy Materials & Solar Cells, 90: 1555–1578.

[10] Hohm,D.P., and Ropp,M.E. 2003. Comparative Study of Maximum Power Point Tracking Algorithms, Progress in Photovoltaic: Research & Application. 11:47– 62.

[11] Lalouni,S., Rekioua.D., Rekioua,T. and Matagne E., 2009. Fuzzy logic control of stand-alone photovoltaic system with battery storage, Journal of Power Sources 193: 899–907.

[12] M. Azab.: A New Maximum Power Point Tracking for Photovoltaic Systems , Procedings of World Academy of Science, Engineering and Technology Volume 34 October 2008 ISSN 2070-3740.

[13] Liu Xuejun.: An improved perturbation and observation maximum power point tracking algorithm for PV panel, thesis Presented for the Degree of Master of Applied Science at Concordia University Montreal, Quebec, Canada, June 2004